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Communication Earplug and Active Noise Reduction: Hearing Protection Technologies for Air Warrior

(Reprint)

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The U.S. Army Aeromedical Research Laboratory (USAARL) participated in the development and testing of two emerging hearing protection technologies for Army aircrew members: communications earplug (CEP), and active noise reduction (ANR). Air Warrior is a program to develop the next generation, integrated, aircrew life support, and combat protection ensemble. The CEP or ANR may be part of the Air Warrior hearing protection strategy.

This article compares the two technologies for compatibility with the Army aircrew member helmet and aircraft internal communication systems. In their current state of development, CEP provides better hearing protection, speech discrimination, and crash protection, lower weight and cost, and less need to modify existing aircraft systems compared to ANR.

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Communication earplug and active noise reduction: Hearing protection technologies for Air Warrior

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Introduction

The U.S. Army Aeromedical Research Laboratory (USAARL) participated in the development and testing of two emerging hearing protection technologies for Army aircrew members: CEP, communications earplug; and ANR, active noise reduction. Air Warrior is a program to develop the next generation, integrated, aircrew life support and combat protection ensemble. CEP or ANR may be part of the Air Warrior hearing protection strategy.

The Tubephone, an earlier concept

Do not confuse CEP with another ear communications device, the ER-2™ Tubephone (Etymotic Research). ER-2™ was a soft plastic tube curving over the top crease of the ear lobe and around into the ear canal. Even though the ER-2™ Tubephone was not designed for use with helmets, it was tried in the Comanche development program. The device was very uncomfortable when worn under an earcup within an aircrew helmet. A signal conversion device about the size of a match box was attached to the back of the test helmet. USAARL found the ER-2™ concept unusable in Army helmet systems.

Communication earplug

The prototype CEP (Figure 1) was developed by USAARL's small business, innovative research program. CEP is a small earphone inside a foam earplug. It is slightly larger than the yellow foam E-A-R™ plugs we use routinely in Army aviation. When soiled, the foam earplug on the CEP is easy to replace. Two small wires are connected to the end of the CEP earphone. On the other end, the CEP wires connect directly into an adapter placed between the helmet communications connector and the aircraft intercommunications system (ICS) receptacle. The adapter permits easy connection of the prototype CEP to current Army aircraft ICSs for testing.

Active noise reduction

The ANR system, composed of electronic components and earphone, is built into a helmet earcup. It continuously measures sound in the earcup. The ANR system filters and reverses the phase of the measured sound. ANR processed sound waves are emitted into the earcup. These processed sound waves combine with the ambient sound waves resulting in attenuated sound levels in the earcup. This is similar to tuning the amplitude and frequency of two waves sets on the ocean traveling toward each other, or overtaking each other, so that they reduce or cancel each other out when they meet.

Comparison CEP and ANR

Table 1 compares the advantages and disadvantage of CEP and ANR. Figure 2 compares the sound attenuation capabilities of the HGU-56/P helmet (next generation Army aircrew head gear), HGU-56/P with E-A-R™ foam earplug, HGU-56/P with CEP, and HGU-56/P with one of the best ANR systems available today (DAT-DRA-SPH4-4B, developed by the Defense Research Agency in Great Britain). These comparisons are based on USAARL's controlled laboratory and flight testing of these devices accomplished as of July 1994.

During initial CEP testing at USAARL, some Army aviators used CEP during normal flying duties. The aviators did not want to give the prototype CEP devices back. They claimed remarkable improvement in speech intelligibility. USAARL is conducting CEP comfort and speech intelligibility tests in all age groups and genders of aircrew members in the last half of FY94.

Future plans

USAARL is taking CEP to the next design phase, which integrates CEP into a standard helmet system. USAARL is designing new approaches to helmet communications. One idea is to integrate CEP and a miniature microphone at the end of a moldable, small diameter, plastic microphone boom into a comfort cap. One standard communications wire with connector plug would exit from the back of the comfort cap for connection to the aircraft ICS. Later, the aviator would don their helmet to provide impact and additional hearing protection.

The earcup holding the ANR system must offer the same crashworthiness as the HGU-56/P earcup or better. ANR must provide better speech discrimination over a greater range of noise frequencies for use in rotary-wing aircraft. The weight of current ANR systems must be reduced significantly. Helmet weight is at a premium in future Army aviator head gear ensembles. Engineers must modify existing avionics to power ANR devices. ANR costs need to be reduced significantly.

Army aircrew members who have design ideas or who want to volunteer to test these devices may contact Mr. Ben Mozo, Aircrew Injury Branch, USAARL, Fort Rucker, AL, 36362, COMM (334) 255-6804/6906/6825, DSN 558-6804/6906/6825.

Table 1.
Comparison CEP and ANR.

CEP	ANR
CEP advantages: 1. Speech intelligibility better than standard aircrew helmet alone, helmet with foam E-A-R™ plugs, and ANR systems. 2. Hearing protection better than standard aircrew helmet alone, and as good as ANR. 3. Light weight. 4. Requires no power sources, works off standard aircraft communication system. 5. Ten times less expensive than ANR. 6. Noise protection is not affected by wearing glasses. **CEP disadvantages:** 1. Device must be actively placed in the ear by aircrew member. 2. Soiled foam tips must be actively replaced or cleaned by aircrew. 3. Need to integrate a miniature microphone system with CEP to reduce number of wires used by current CEP prototype.	**ANR advantages:** 1. Passive system, aircrew members simply put on their helmets to use ANR. 2. Speech intelligibility better than standard helmet alone, or helmet with foam E-A-R™ plugs. 3. Better hearing protection than standard aircrew helmet alone. **ANR disadvantages:** 1. Speech intelligibility not as good as CEP. 2. Noise protection decreased by wearing glasses or poor earcup fit. 3. Heavy weight, weight is at a premium in modern vision-coupled aircrew helmets. 4. Requires new power source not available in current aircraft communication systems. 5. Ten times more expensive than CEP. 6. Current ANR systems degrade the crashworthiness of Army aircrew helmets. 7. Component reliability in operational environment is unknown.

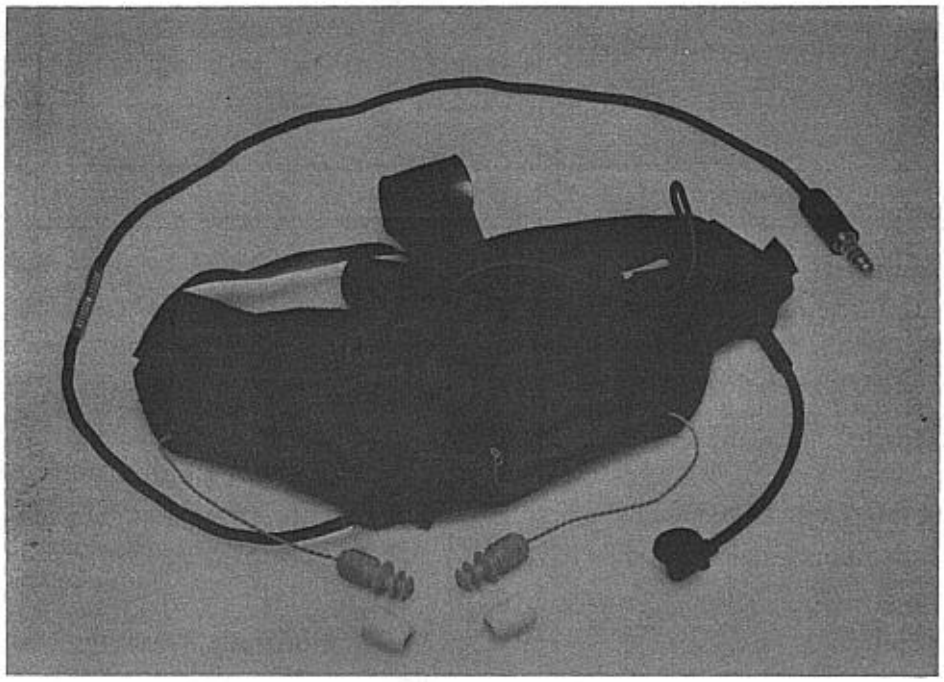

Figure 1. Prototype USAARL communications earplug (CEP).

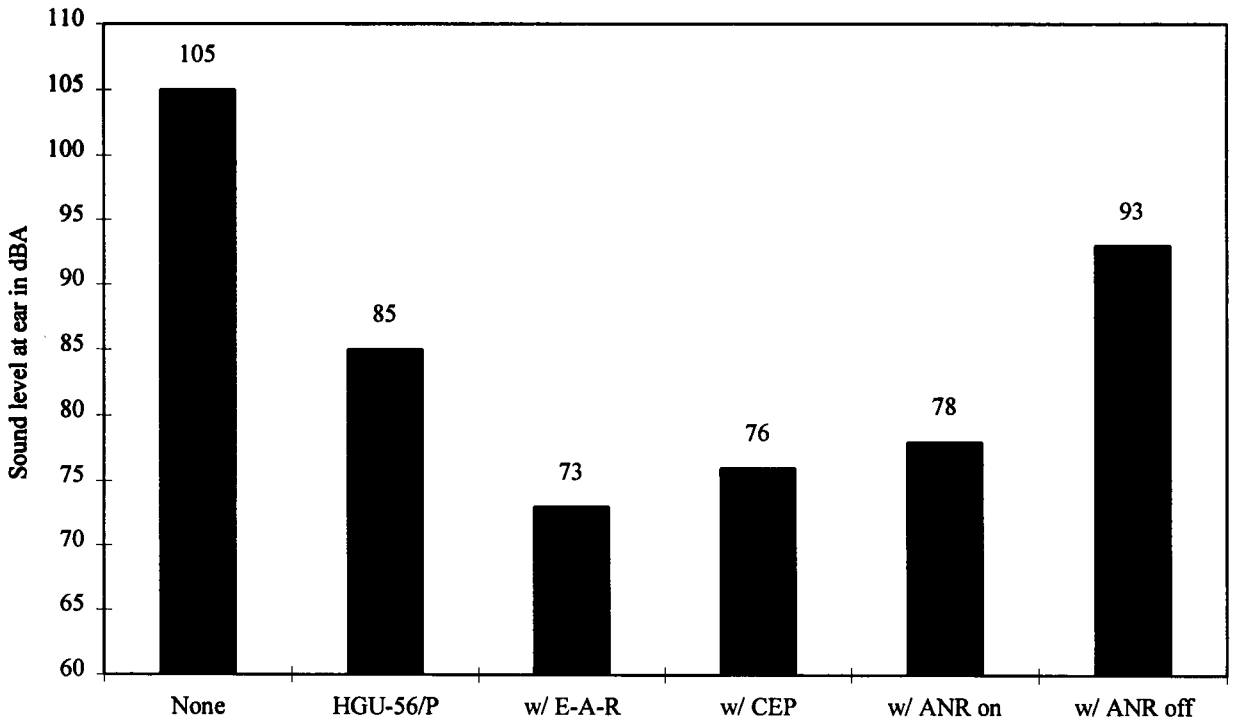

Figure 2. Sound attenuation of HGU-56/P with various additional ear devices in a simulated UH-60 Black Hawk noise environment.